DRAFT

PRIVILEGED

FILE PLAN 2.0

335132

7251

FINAL REPORT
RICHARDSON FLATS TAILINGS
SUMMIT COUNTY, UTAH
TDD #T08-9204-015
PAN EUT0039SBA

PREPARED FOR:

U.S. Environmental Protection Agency
Region VIII
Waste Management Division
Mike Zimmerman, On-Scene Coordinator

PREPARED BY:

Scott Keen
Ecology and Environment, Inc.
Technical Assistance Team

DATE SUBMITTED: October 23, 1992

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

FINAL REPORT
RICHARDSON FLATS TAILINGS SITE
TDD #T08-9204-015 PAN EUT0039SBA

DRAFT

INTRODUCTION AND PURPOSE

This report is written to satisfy the requirements of Technical Direction Document (TDD) #T08-9204-015 issued to to the Ecology and Environment, Inc. Technical Assistance Team (E & E-TAT) by the Region VIII U.S. Environmental Protection Agency (USEPA) Emergency Response Branch (ERB). This work was begun in April 1992, and although this report is a final report summarizing activities and findings to date, it is likely that additional work will be performed under this TDD. Other reports submitted by the TAT under this TDD include: Trip Report, Richardson Flats Tailings Site, August 17, 1992; and Inspection of the Tailings Dam at Richardson Flats, Memorandum to EPA-OSC, August 6, 1992. Within this same time frame the TAT has also performed work relevant to the site under two separate TDDs (T08-9204-041 and T08-9207-019). Reports/documents generated by the TAT as a result of these two TDDs are: the "Report of Drilling Activities, Richardson Flats Tailings Site, July 13, 1992"; and "Response to PRPs September 10, 1992 Memorandum Regarding Well Installation Activities, Memorandum to EPA/OSC, September 11, 1992".

Also relevant to this work is the report entitled "Air Sampling and Analysis, Final Report", August 1992, prepared by the Environmental Response Team (ERT) of the USEPA.

The Richardson Flats Tailings site is located three and one-half miles northeast of Park City, Summit County, Utah. On approximately 160 acres from 1975 through 1981 mine tailings were placed by slurry pipeline from mines owned by United Park City Mines (UPCM). A small portion of the site was also used for a municipal/sanitary landfill during the mid-1970s.

The Richardson Flats Tailings site appeared in the Federal Register on February 7, 1992 as a proposed National Priorities List (NPL) site. Because of this proposed listing the USEPA/ERB became responsible for assuring immediate site safety for the interim period following proposed listing through the initiation of remedial activities. The purpose of this work has thus been to examine the site in terms of immediate threats to human health or the environment. This report is a summary of findings to date.

SITE ACTIVITIES

Following an initial site visit in April 1992, the TAT prepared a work plan to assess contaminant releases to groundwater, surface water, and to the local environment via the air pathway. Contaminants of concern include metals from the tailings area and the landfill area, and several types of potential organic contaminants from the landfill area.

Additional monitoring wells were installed at the site during the week of June 22, 1992. Air monitoring was conducted by the ERT on June 10 and 11, 1992. During the week of August 3, 1992 the TAT was on-site for several activities including groundwater and surface water sampling, determination of depth of cover on the tailings area, sampling of cover soil material, and inspection of the tailings containment structure and diversion ditch system. Additional groundwater sampling and analysis will likely be performed following submission of this report.

RESULTS AND FINDINGS

AIR MONITORING

In July 1986 air monitoring documented the airborne release of arsenic, cadmium, lead, and zinc in particulate form from the Richardson Flats Tailings site. Since that time UPCM has placed cover soil over approximately 85% (UPCM's estimate) of the tailings area. On June 10 and 11, 1992 air samples were again collected to assess the airborne release of these four metals. At 5 sampling locations on the site's perimeter boundary 17 air samples were collected. The sampling procedure and analytical results are contained in their entirety in the Air Sampling and Analysis, Final Report, Richardson Flats, August 1992 prepared by the USEPA/ERT. In summary, these air monitoring activities showed no detectable levels of cadmium, lead, or arsenic in any samples. Trace levels of zinc (at the level of quantitation) were detected in four samples only. No samples on any day under any wind condition exhibited elevated levels of contaminants. Restriction from site access precluded the implementation of the optimum sampling strategy; however a conclusion can still be made that airborne releases of contaminants from the Richardson Flats Tailings site are not posing an immediate threat to human health or the environment.

TAILINGS ASSESSMENT

DEPTH OF COVER

Depth of cover was determined at 29 locations over the tailings area. These locations are depicted on Figure 2. Locations were determined by first establishing a reference line in an approximate direction of northwest to southeast through the tailings area (Figure 1). This reference line includes and is a continuation of a straight portion of the tailings containment structure as shown in Figure 1. Points were marked along this reference line at 200 or 400 foot intervals. At 2800 feet from the base point a second reference line was established in a perpendicular direction to the first reference line. This second reference line extended in an approximate direction from southwest to northeast. For the purpose of sampling or soil cover measurements, all locations within the tailings area were identified relative to these two reference lines. For example, a sample location identified as 1900, 800L would be 1900 feet from the base point (using the first reference line) and 800 feet to the left (northeast) using the second reference line.

Sample locations were on an approximate grid pattern of 400 feet x 400 feet. The grid covered most of the tailings area. Table 1 presents the results of cover depth measurements. At all but one location a distinct line could be seen between soil cover and gray colored tailings beneath the cover. X-ray fluorescence (XRF) measurements for lead were taken to confirm the visual determination of cover depth or to determine cover depth where a distinct line was not visible. As seen in Table 1, much of the tailings area is covered with a salt grass. This is a native grass which appeared to form an excellent cover on the tailings. Where the salt grass is present no soil cover had been placed over the tailings; however roots of the grass extended five to six inches below ground surface, and the roots and the grass itself formed an effective dust suppressing mat on top of tailings material.

The grid pattern shown in Figure 2 represent much of the entire tailings area. Of the 29 points on this grid only 1 point had no cover soil and no salt grass present. Nine of the 29 points (approximately 30 percent) had no cover soil present. At the 20 points where cover soil was present, the cover soil was 6 inches thick or less at 6 points and greater than 6 inches in thickness at 14 points.

It is important to note that the salt grass which became established on the tailings area is likely dependent upon a moist environment for survival. This grass became established when tailings were slurried to the site creating periods of standing water. The grass may slowly disappear, and its extensive root system may make conditions difficult for other plants to become established.

UPCM has expressed intentions of adding soil cover to that small portion of the site which currently has no soil cover or where salt grass is not established. When this is completed the tailings area will have adequate cover to prevent an immediate threat of excessive dust. Much of the existing soil cover, however, is sparse (less than six inches in thickness); and much of the area is covered with a salt grass that may disappear as the site becomes drier. Dusty conditions could recur in the future if proper soil cover over the entire tailings area is not applied.

COVER SOIL ANALYSES

Figure 2 shows the location of six soil samples collected on August 6, 1992. Each of these samples, except sample RF-SO-3, was taken from soil that was added by UPCM as cover to the site. Table 2 contains analytical results for these samples and the normal ranges for these elements in soils of the western United States. Sample RF-SO-3 was collected within an area covered by salt grass. As discussed, where salt grass is currently established soil cover has not been added by UPCM. This soil sample is more likely to be representative of tailings material.

As Table 2 shows, constituents of soil cover do not consistently fall into the normal ranges for all elements. In soil cover samples, however, no contaminant is grossly out of line from the normal ranges presented in Table 2. Results for sample RF-SO-03 show very high concentrations of antimony, arsenic, cadmium, copper, lead, mercury, selenium, and zinc; however this sample is tailings, not cover material. It appears that soil being used for cover material by UPCM does not contain contaminants at concentrations that would pose an immediate threat to human health or the environment.

TAILINGS CONTAINMENT

On August 4, 1992 the TAT inspected the tailings containment structure. This inspection did not include trenching or boring into the embankment and thus was not a full assessment of the structure. Results of this inspection were summarized in a memorandum to the OSC dated August 8, 1992. This memo is included with this report as Appendix A. Important findings of this inspection follow.

1. Main Embankment.
   The main embankment is oversteep lying at 1.0:1.0 to 1.5:1.0 (run:rise). Approximately six inches of fine dry sand, possibly windblown tailings, were noted under a three inch topsoil cover layer on the downstream face of the embankment. The sand has no strength and will erode quickly if exposed. A 35% to 50% grass cover was on most of the embankment which will help in erosion control. No cracking was evident on the embankment, although the sand layer would tend to hide any small cracking. Also, no bending (bulging) was noted on the embankment.

2. Toe of the Main Embankment.
   Rank vegetation, in the form of willows and trees, is growing at the toe of the dam. Approximately eight inches of loamy damp soil is evident on the toe of the dam. The amount of vegetation and the type of soils on the toe of the dam indicate that the area receives a lot of water. As the wet soils were noted approximately six to eight feet above the stream level this water is probably due to seepage under the dam. Other evidence of seepage from the toe of the dam was evident in the forms of; soft marshy areas, rank vegetation including willows, loamy soils, damp soils, and areas where water had been standing (although no standing water was observed on August 4, 1992).

3. The North Abutment.
   A swampy, loamy area on the north abutment, adjacent to where the embankment meets the abutment, was noted. The area was well above the toe of the dam at the location of the north monitoring well. This well recharged quickly when bailed. These conditions indicate that water seeps around or through the contact between the abutment and the embankment. Under full head conditions (saturated tailings) this would be an area where failure of the embankment could occur.

4. Crest of the Main Embankment.
   The crest is sloped back toward the tailings area allowing any water to drain back to the tailings pond. However, small erosional gullies are forming on the crest and downstream face

of the dam and could eventually lead to larger gullying on the dam.

5. Water Flow.
   Water elevations behind the embankment are unknown, however the elevation of water in the ditch and the pond south of the tailings area are probably indicative of the elevation of groundwater behind the embankment. From the information available in the Dames & Moore, Inc. reports, it is unlikely that a cutoff wall was installed around the perimeter of the pond to control seepage under either the embankment or the dike. The piezometer located on the toe of the dam indicated the water level to be five feet below ground. The swampy ground and recharge rate of the monitoring well on the north abutment indicates that water flow from some source is occurring. Inspection of the road cut north of the abutment revealed no seeps. Without further investigation it is conservative to use a worst case scenario and assume that the source of the seep is the water in the tailings behind the dam and that the abutment/embankment contact is a drainage path for the water.

6. Perimeter Dike.
   The perimeter dike was probably constructed by stripping materials off of the downstream side and piling the undifferentiated material up as a dike. The slopes are approximately 2.0:1.0. The dike is used as the access road for the pond and its elevation varies from two to five feet above the level of the tailings in the pond. The dike appears to be in good condition.

7. Diversion Ditch.
   The diversion ditch has been constructed along the perimeter of the tailings pond as designed by Dames & Moore, Inc. The ditch depth and width varies, generally getting deeper and wider as it progresses downstream. Standing water was evident in most of the ditch on the southern perimeter of the property. Rushes, sedges, and cattails wee growing in the bottom of the ditch along the entire length. Recent work has been performed by the owners in flattening the ditch banks and adding topsoil to the banks. This work is approximately one-half completed. According to the owners, the rest of the ditch is to be similarly regraded and topsoiled. At the time TAT inspected the site, the hillside diversion ditch, on the north perimeter of the tailings pond, had been cut off from the main ditch as a result of topsoil stripping. This important feature should be reconnected to the main ditch as soon as possible to prevent additional water flowing into the tailings pond.

In conclusion, based on the observed conditions of the tailings containment or embankment structure and the relatively dry condition of the tailings, there is no immediate threat of gross failure of this structure. Of more immediate concern are: seepage from the toe of the dam evidenced by wet/saturated soil well above stream level; seepage around or through the contact between the abutment and the embankment near the location of the northernmost groundwater monitoring well; and the hillside diversion ditch located on the north perimeter of the tailings area which has been cut off from the main drainage ditch by topsoil stripping activities allowing runoff into the tailings area.

Recommendations include keeping the tailings area dry through the maintenance of the diversion ditches. The connection between the hillside diversion ditch and the perimeter diversion ditch should be restored.

SURFACE WATER

Surface water samples collected for assessment of the tailings area are shown on Figure 1. These eight sample numbers are RF-SW-01 through RF-SW-08. Inorganic analytical results for surface water samples are presented in Table 3. Within Silver Creek samples RF-SW-01 through RF-SW-04 are considered upgradient of the tailings area and samples RF-SW-05 and RF-SW-06 are downgradient. In comparing upgradient sample results with downgradient sample results very few significant differences are noted. Lead increases by a factor of 5.7 in sample RF-SW-05 when compared to the average lead concentration of the four upgradient samples. In sample RF-SW-06 arsenic increases by a factor of 2.1 and silver increases by a factor of 4.2 when compared to the average concentration of the four upgradient samples.

It is important to realize the in surface water most metals will be quickly oxidized, precipitate, and tend to settle out of the bulk water and became incorporated into stream sediment. Thus, metals in surface water generally are transported in particulate/suspended form. In a very low flow period of the year (August), when surface water is not turbulent, metals are not transported to the extent that they are transported during higher flow conditions.

The Utah Code, 26-11-2 through 20, has classified the Weber River from the Stoddard diversion to the headwaters (including Silver Creek) in the following manner: IC-protected for domestic purposes with prior treatment by treatment processes as required by the Utah Department of Health; 3A-protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain; and 4-protected for agricultural uses including irrigation of crops and stock watering. The Utah Code establishes specific numeric criteria for contaminants based upon use classification.

Applicable inorganic standards from the State Code are summarized in Table 4. The Utah Code prohibits discharges or placement of wastes in such a manner that will cause violations of these numerical standards. The State has designated Silver Creek to be in three use classes (1C, 3A, and 4). For the domestic source class (1C) upgradient samples from Silver Creek meet all standards. The two downgradient Silver Creek samples meet all standards except that for lead in sample RF-GW-05. The data indicates that during this sampling event a violation of the lead standard for the State Domestic Source (1C) surface water class was caused by discharges from the Richardson Flat tailings site. For the Agricultural Class (4) the data also indicates a violation of the lead standard in sample RF-SW-05.

State standards for Class 3A Surface Waters, protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain, are divided into four day average (chronic) standards and one hour average (acute) standards. Grab samples collected during the week of August 4, 1992 could only be compared to the acute standards. This comparison shows that upgradient and downgradient samples from Silver Creek meet all Class 3A standards, except those standards for lead and zinc which are exceeded in both upgradient and downgradient samples.

The State Code also contains numeric standards for surface waters for the protection of human health. Those applicable inorganic standards are presented in Table 3. All upgradient and downgradient samples from Silver Creek meet the human health standards for antimony, cadmium, chromium, copper, silver, selenium, and zinc. Both upgradient and downgradient samples fail to meet human health standards for arsenic and beryllium. One upgradient sample, RF-SW-02, does not meet the human health criteria for nickel. One downgradient sample, RF-SW-05, does not meet the human health standard for lead.

What is important to this report when examining inorganic analytical data for Silver Creek and when considering the several state standards for the protection of surface waters? The detection of lead in one downgradient sample at 151 µg/l is likely the most significant observation. This lead level and the relatively low lead concentration in the four upgradient samples constitutes a violation of the State Code for protection of Class 1C and Class 4 surface waters. Sample RF-SW-05 also demonstrates a violation of the state standard for protection of human health. This sample may help to confirm the findings of earlier studies or highlight an area of concern for later remedial activities. In the context of this project, however, this observation of an elevated lead level in one of two downgradient surface water samples cannot be seen as posing an immediate threat to human health or the environment. A "release" has been documented, however the documentation of an ongoing event is sparse.

GROUNDWATER

One upgradient and two downgradient monitoring wells (Figure 1) were sampled during the week of August 4, 1992. Results of inorganic analyses are presented in Table 6. Sample RF-GW-04 is from the upgradient well; samples RF-GW-05 and RF-GW-09 are from two wells at the base of the tailings dam.

Calculation of total dissolved solids (TDS) level of the upgradient well shows upgradient groundwater to contain less than 500 parts per million (ppm) TDS. This finding is consistent with upgradient TDS concentrations found during previous sampling activities in August 1985.

State of Utah Wastewater Disposal Regulations, Part II, Standards of Quality for Waters of the State establishes classes of groundwater.

If only filtered samples are considered, upgradient groundwater would be classified 1A, Pristine Groundwater. If unfiltered samples are evaluated, upgradient groundwater would be classified III, Limited Use Groundwater. State regulations also establish protection criteria which prohibit discharges to groundwater that would cause violations of the numeric groundwater quality standards.

Comparison of upgradient versus downgradient water quality from Table 1 shows that no individual contaminants increase to concentrations that would cause violations of either Class 1A or Class III groundwater protection standards. TDS levels, however, show increases (downgradient versus upgradient) well in excess of the protection standards for either Class 1A or Class III groundwaters. This increase in TDS of groundwater is attributed to the influence of tailings material on water chemistry and constitutes a violation of state regulations pertaining to the protection of groundwater quality.

SEDIMENT

Figure 1 shows a "wetlands" area between the base of the tailings dam and Silver Creek. Within this area four sediment samples were collected. Results of inorganic analyses of these samples is presented in Table 7 along with the normal ranges of elemental concentrations in soils of the western United States.

Analytical results show the following. Antimony is present at levels 39 to 98 times higher than the normal maximum concentration in soils of the western United States. Arsenic is present at levels 11 to 28 times higher than the normal maximum concentration in soils of the western United States. Cadmium is present at levels 75 to 210 times higher than the normal maximum concentration in soils of the western United States. Lead is present at levels 75 to 210 times higher than the normal maximum concentration in soils of the western United States. Mercury is present at levels 11 to 74 times higher than the normal maximum concentration in soils of the western United States. Selenium is present at levels 17 to 76 times higher than the normal maximum concentration in soils of the western United States. Zinc is present at levels 55 to 410 times higher than the normal maximum concentration in soils of the western United States.

Water flow through the wetlands area is now primarily from the diversion ditch. Some seepage from the tailings area through or around the containment structure may also influence flow and/or chemistry of this wetlands (See Report Section on Tailings Containment). Flow is toward Silver Creek, and this badly contaminated sediment appears to be tailings material that is being transported from the site.

In Table 2, Inorganic Analytical Results for Soil, sample RF-SO-03 was a sample of tailings material. This tailings sample showed the following ratio of six elements: arsenic (4.3); cadmium (1); calcium (713); iron (811); lead (70); and zinc (120). In Table 7, Inorganic Analytical Results for Sediment, the four sediment samples plus one duplicate, when averaged, show the following ratio of the same six elements: arsenic (3.1); cadmium (1); calcium (904); iron (805); lead

(72); and zinc (162). These ratios of elements are very similar and likely indicate that sediment in the wetlands area is tailings material from the site.

LANDFILL ASSESSMENT

GROUNDWATER

Three monitoring wells were installed in the area of the landfill; however at this time these wells have not yet been sampled.

SURFACE WATER

Of the six surface water sample locations shown in Figure 1, two locations (RF-SW-01 and RF-SW-02) were upgradient of the landfill; the other locations were downgradient. Comparison between upgradient and the two closest downgradient samples (RF-SW-03 and RF-SW-04) of inorganic data (Table 6) show no significant increases in contaminant concentrations as Silver Creek flows past the landfill.

These six surface water samples were also analyzed for organics (VOAs, BNAs, Pesticides/PCBs). In all samples no pesticide/PCBs were detected at or above the instrument detection level. One BNA compound, bis(2-ethylhexyl)phthalate, Cas Number 117-81-7, was detected at concentrations between 0.6 and 1 µg/l at sample locations RF-SW-01, RF-SW-02, RF-SW-03, and RF-SW-04. This compound is a very common contaminant associate with plastics. At the very low levels detected its presence cannot be considered significant. Toluene was detected at 3 µg/l at three sample locations, RF-SW-01, RF-SW-02, and RF-SW-03. At these very low concentrations the presence of toluene is not a certainty; however because two of the three sample locations were upgradient of the landfill, the presence of this contaminant would not be attributed to the landfill.

In summary, no significant findings came from the organic analyses of surface water samples.

SITE ACCESS

A security fence has been put in place surrounding the site. Based upon the TAT's inspections and observations during site activities and based upon observations made by UPCM this security fence has been very effective at preventing access to the site. Before the security fence was constructed, the site was most notably used by "off road" motorcycle enthusiasts.

CONCLUSIONS

AIR MONITORING

Air sampling and analysis found no detectable levels of contaminants being transported from the site.

TAILINGS ASSESSMENT

Depth of Cover. When UPCM completes its program of adding soil cover to the tailings area, there will be no immediate threat of excessive dust conditions. However, much of the existing soil cover is sparse and much of the area is "covered" with a salt grass that may disappear as the site becomes drier. Dusty conditions could recur if proper soil cover over the entire tailings area is not applied.

Cover Soil Analyses. Although soil being used for cover material by UPCM contains contaminants at concentrations slightly beyond the normal concentration ranges of soils of the western United States, no contaminants are present at levels that would pose an immediate threat to human health or the environment.

Tailings Containment. These are no immediate threats of gross failure of this system; however seepage from tailings through or around the dam and an interruption in the drainage ditch on the site's northern perimeter are concerns which must be given attention.

Surface Water. A release of lead to surface water was documented by these sampling activities. This release causes a violation of state water quality protection standards, however documentation of an ongoing event is sparse, and it is difficult to view this incident as evidence of an immediate threat to human health or the environment.

Groundwater. Comparison of upgradient versus downgradient groundwater shows no increases in concentrations of specific contaminants attributable to the site. However, TDS levels do increase due to the influence of tailings material on groundwater chemistry causing a violation of state water quality protection standards.

Sediment. Sediment in the wetlands area immediately northwest of the tailings dam and attributable to the site shows very high concentrations of several metals including arsenic, cadmium, lead, selenium, and zinc.

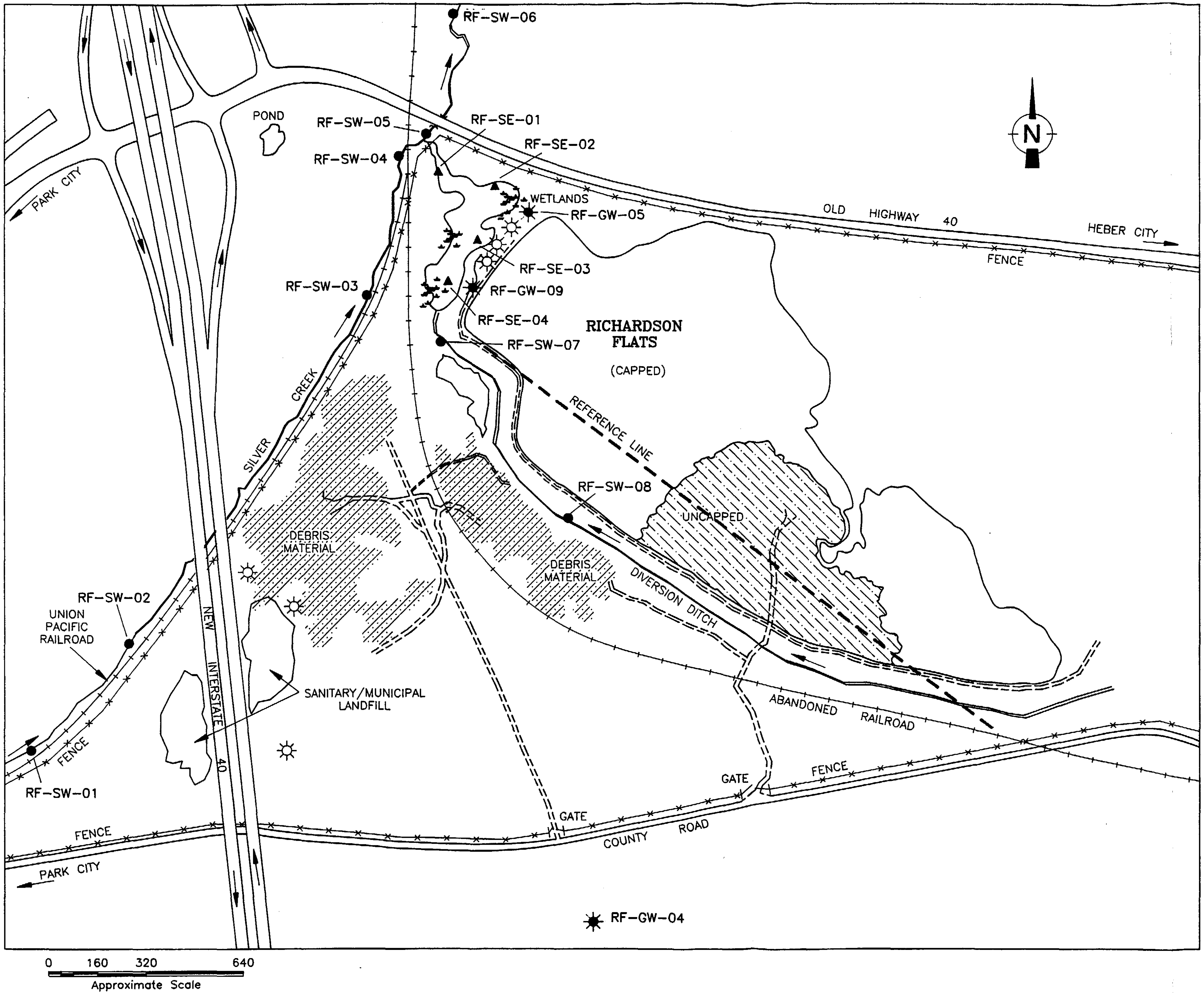
LANDFILL ASSESSMENT

Groundwater. Monitoring wells surrounding the landfill area will be sampled and analyzed in November 1992.

Surface Water. During these sampling activities no contaminants were detected in Silver Creek that could be attributed to the landfill.

SITE ACCESS

Due to a well-constructed fence that entirely encloses the site, access to the site has been effectively restricted.



LEGEND

- Approximate location of monitoring wells
- Groundwater sample location
- Surface water sample location
- Sediment sample location

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0037

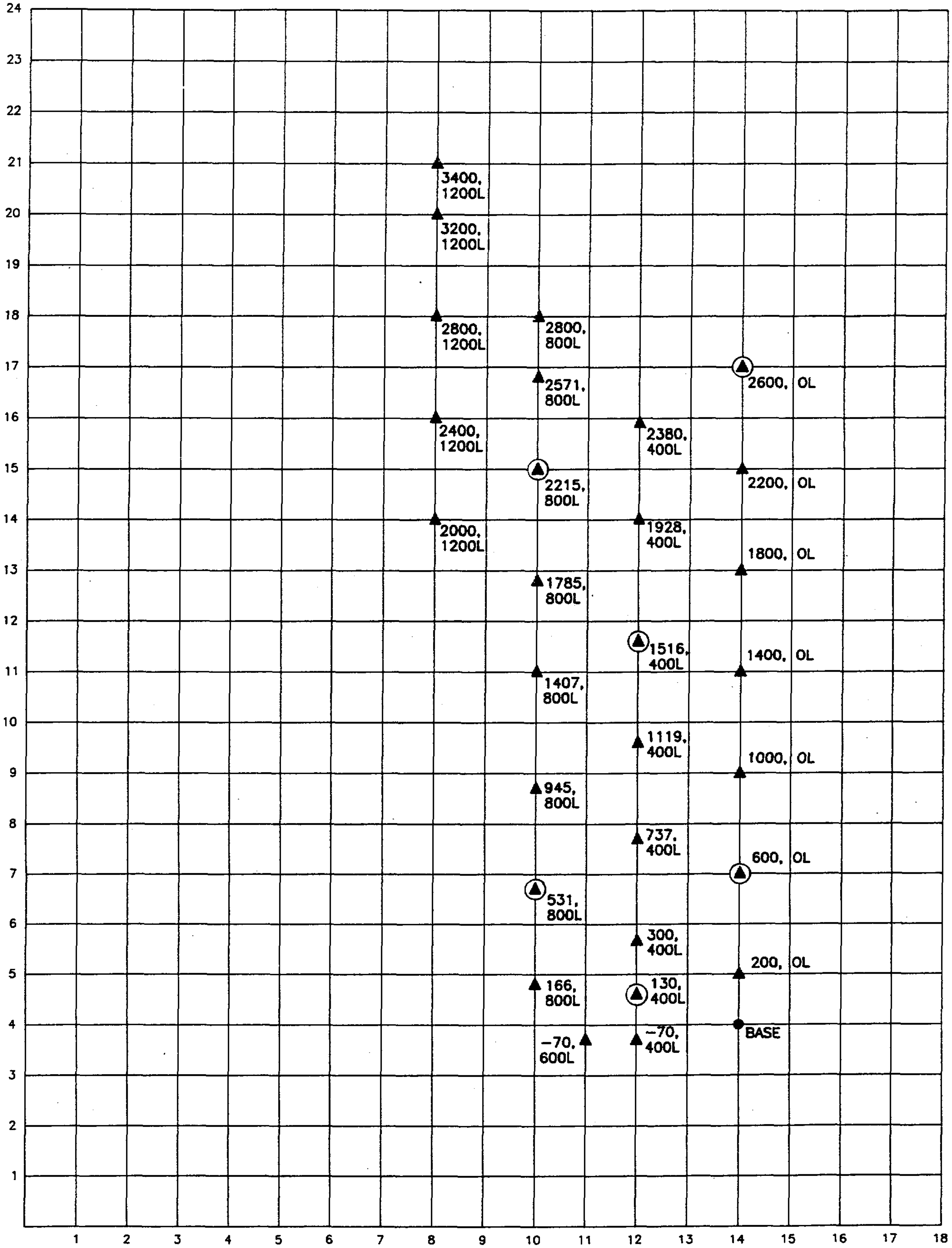
TITLE:
RICHARDSON FLATS
Park City, Utah
SAMPLE LOCATION MAP

T.D.D. T08-9204-015

ecology & environment, inc.
DENVER, COLORADO

FIG. 1

Date: 08/92 Drawn by: RSM Scale: ______



LEGEND

▲ Cover depth determined   (▲) Cover sample collected

RICHARDSON FLATS
August 4, 5, 6, 1992

TABLE 1
COVER DEPTH MEASUREMENT
RICHARDSON FLAT TAILINGS SITE
TDD #T08-9204-015

LOCATION	DEPTH OF COVER	VISUAL CONFIRMATION	XRF CONFIRMATION	XRF SAMPLE NUMBERS
200, 0L	10"	Yes	Yes	RF020, 021
600, 0L	3-6"	Yes	Yes	RF022,023,024,025
1000, 0L	>18"			
1400, 0L	>18"			
1800, 0L	>18"			RF026
2200, 0L	0-6"	No	Yes	RF027,028,029,030
2600, 0L	6-10"	Yes	Yes	RF032,033,034,035
2380, 400L	8-9"	Yes	Yes	RF036,037,038,039
1928, 400L	5-6"	Yes	Yes	RF040,041,042
1516, 400L	>6"			
1119, 400L	4"	Yes	Yes	RF044,045
737, 400L	7-8"	Yes	Yes	RF048,049,050
330, 400L	8"	Yes	Yes	RF055,056
2800, 800L	No Cover (Salt Grass)	Yes	Yes	RF057,058,059,060
2571, 800L	No Cover (Salt Grass)	Yes	Yes	RF061,062
2215, 800L	No Cover (Salt Grass)	Yes	Yes	RF063,064
1785, 800L	No Cover (Salt Grass)	Yes	Yes	RF065,066
1407, 800L	3"	Yes	Yes	RF067,068,069
945, 800L	6-7"	Yes	Yes	RF071,072,073
531, 800L	7-8"	Yes	Yes	RF074,075
166, 800L	No Cover	Yes	Yes	RF076,077
130, 400L	2"	Yes	Yes	RF080,081,082
-70, 400L	6.5"	Yes	Yes	RF083,084,085
-70, 600L	11"	Yes	Yes	RF086,087,088,089
2000, 1200L	No Cover (Salt Grass)	Yes	Yes	Rf091,092
2400, 1200L	No Cover (Salt Grass)	Yes	Yes	RF093,094
2800, 1200L	No Cover (Salt Grass)	Yes	Yes	RF095,096
3200, 1200L	No Cover (Salt Grass)	Yes	Yes	RF097,098
3400, 1200L	>10"	Yes	Yes	RF099,100

TABLE 2
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SOIL
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	NORMAL RANGE (mg/kg)	RF-SO-01	RF-SO-02	RF-SO-03	RF-SO-04	RF-SO-05	RF-SO-06
Aluminum	29000-116000	21200	25300	2960	25800	22000	25200
Antimony	0.22-1.01	5.0UN	5.0UN	142N	5.0UN	5.7BN	5.6BN
Arsenic	2.8-10.9	20.9S*	3.5*	357*+	5.9*	16.6	8.9
Barium	337-998	253	282	117	267	317	197
Beryllium	0.30-1.56	1.1	1.1	1.2	1.2	1.1	1.2
Cadmium	0.01-2.0***	3.0EN	1.8EN	83.0EN	1.9EN	5.0EN	2.4EN
Calcium		5850	5900	59200	5900	9480	4920
Chromium	19-90	24.4N	27.9N	12.9N	22.2N	24.3N	28.2N
Cobalt	3.6-14.0	13.9	12.7	12.6	15.0	14.5	10.0B
Copper	10-43	31.4	24.8	454	27.2	50.4	29.4
Iron	10600-41000	21800	25600	67300	23500	27500	23100
Lead	9-31	111	34.9S	5770	125+	223	102
Magnesium		4910	5200	10100	5150	4780	5570
Manganese	192-752	1190	637	2020	899	1030	697
Mercury	0.02-0.11	0.11U*	0.11U*	3.6*	0.10U*	0.11U*	0.16*
Nickel	7-32	20.7	21.6	18.5	18.4	21.3	19.9
Potassium		4730	4580	917	4330	4540	5650
Selenium	0.09-0.56	0.61UNW	0.61UNW	25.4N	0.61UNW	0.61UNW	0.61UNW
Silver	0.01-8***	4.1N	2.0N	20.3N	2.0N	2.0N	2.0N
Sodium		136B	319B	209	244B	248B	159B
Thallium	0.1-0.8***	0.35B	0.43B	41.7S	0.59B	1.9B	0.32U
Vanadium	36-136	41.4	56.3	13.0	51.4	57.4	42.2
Zinc	31-98	214	96.3	10000	127	432	184

DRAFT

* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

*** - Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

TABLE 3
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SURFACE WATER
CONCENTRATION IN µg/l
TDD #T08-9204-015

ANALYTE	RF-SW-01	RF-SW-02	RF-SW-03	RF-SW-04	RF-SW-05	RF-SW-06	RF-SW-07	RF-SW-08
Aluminum	20.3B	70.1B	19.3B	65.5B	17.1U	185B	36.7B	319
Antimony	36.7B	24.8B	24.3U	38.7B	24.3U	30.1B	24.3U	24.3U
Arsenic	4.2B	5.2B	7.3B	7.6B	7.2B	12.5	5.7B	11.4
Barium	49.2B	54.6B	50.5B	54.4B	65.6B	66.0B	32.7B	54.3B
Beryllium	3.4B	2.8B	2.1B	2.1B	2.4B	0.93B	3.2B	1.0B
Cadmium	3.9B	3.3U	3.3U	3.5B	3.3U	3.3U	3.3U	3.3U
Calcium	233000	157000	128000	149000	163000	146000	341000	190000
Chromium	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	6.0U	6.0U	6.0U	10.4B	6.0U	6.0U	6.0U	6.0U
Copper	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0B
Iron	193	158	307	356	279	446	703	1320
Lead	35.3NS*	18.8N*	15.0N*	36.4NS*	151NS*	33.2N*	33.3NS*	146NS*
Magnesium	38700	37000	30600	33600	36700	37700	61000	38100
Manganese	249E	495E	458E	438E	269E	399E	9230E	1590E
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U	0.24	0.20U
Nickel	11.1U	25.4B	11.1U	11.1U	11.1U	11.1U	12.8B	20.9B
Potassium	3510B	2110B	1640B	1950B	1270B	1400B	3180B	1150B
Selenium	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW
Silver	2.4UN	2.4UN	2.4UN	2.4UN	2.4UN	10.0N	10.0N	10.0UN
Sodium	63600	24500	20900	25500	25900	27600	51200	29500
Thallium	1.6UW	1.6U	1.6U	1.6U	1.6U	1.6U	1.6UW	1.6U
Vanadium	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN
Zinc	1110EN	2080EN	769EN	776EN	466EN	321EN	64.2EN	745EN

DRAFT

TABLE 4
NUMERIC STANDARDS OF QUALITY
SILVER CREEK
STATE OF UTAH
WASTEWATER DISPOSAL REGULATIONS

	DOMESTIC SOURCE (1C) (Max. µg/l)	AQUATIC WILDLIFE (3A) 4 Day Avg./1 Hr. Avg. (µg/l)	AGRICULTURAL (4) (Max. µg/l)	HUMAN HEALTH (B) (µg/l)
Antimony				146
Arsenic	50	190/360 (tri As)	100	.002
Barium	1000			
Beryllium				.0037
Cadmium	10	2.5/12.5[A]	10	10
Chromium	50	11/16 (hex Cr) 480/4035 (tri Cr)[A]	100	50
Copper		28.5/47[A]	200	1000
Iron		1000 (Max.)		
Lead	50	2.5/5.7[A]	100	50
Mercury	2	.012/2.4		.144
Nickel		377/3390[A]		13.4
Selenium	10	5/20	50	10
Silver	50	/24[A]		50
Zinc		254/280[A]		5000

A - Based on hardness level of 280 mg/l as $CaCO_3$.

B - Human health criteria applied to all Class 1C water bodies to protect for the consumption of water and aquatic organisms.

TABLE 5
FEDERAL QUALITY CRITERIA FOR WATER
RICHARDSON FLATS TAILINGS
TDD #T08-9204-015
(Concentration in μg/l Unless Otherwise Stated)

	CRITERIA FOR PROTECTION OF FRESH WATER WILDLIFE		CRITERIA FOR PROTECTION OF HUMAN HEALTH	
	ACUTE CRITERIA	CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY
Antimony	9000*	1600*	1.46	
Arsenic	850 (pent)* 360 (tri)	48 (pent)* 190 (tri)	2.2 ng/l**	17.5 ng/l**
Barium			1 mg/l	
Beryllium	130*	5.3*	6.8 ng/l**	117 ng/l**
Cadmium	12.5A	2.5A	10	
Chromium (hex)	16	11	50	
Chromium (tri)			170 mg/l	3433 mg/l
Copper	46.8A	28.5A		
Iron		1000	0.3 mg/l	
Lead	303A	11.8A	50	
Manganese			50	100
Mercury	2.4	0.012	144 ng/l	146 ng/l
Nickel	3390A	377A	13.4	100
Selenium	260	35	10	
Silver	24A	.12	50	
Thallium	1400*	40*	13	48
Zinc	280A	254A		

From: Quality Criteria for Water, 1986, EPA 440/5-86-001.

A - Calculated based on hardness at 280 mg/l $CaCO_3$.

* - Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).

** - Human health criteria for carcinogens reported for three risk levels. Values presented is the 10^{-6} risk level.

TABLE 6
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER
CONCENTRATION IN μg/l
TDD #T08-9204-015

ANALYTE	RF-GW-04 TOTAL	RF-GW-04 DISSOLVED (FILTERED)	RF-GW-05 TOTAL	RF-GW-05 DISSOLVED (FILTERED)	RF-GW-09 TOTAL	RF-GW-09 DISSOLVED (FILTERED)
Aluminum	15700	191B	2690	49.6B	68.5B	1630
Antimony	24.3U	33.2B	24.3U	40.5B	35.9B	28.4B
Arsenic	3.7B	3.6U	5.2B	3.6UW	8.8B	11.3
Barium	196B	93.9B	99.6B	64.8B	46.2B	58.3B
Beryllium	1.3B	0.90U	3.4B	1.8B	3.7B	4.9B
Cadmium	3.3U	3.3U	3.3U	3.3U	3.3U	3.3U
Calcium	42200	43500	191000	196000	365000	318000
Chromium	10.5	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	11.0B	6.0U	7.5B	6.0U	6.0U	9.0B
Copper	30.0	171EN*	30.0	20.0B	20.0U	20.0U
Iron	14100	151	3180	62.6B	2170	3190
Lead	627N*	40.9N*	15.6NS*	2.2UN*	2.2U	31.0NS*
Magnesium	12200	8380	44200	41800	55000	52500
Manganese	162E	19.5E	890E	684E	7420E	6670E
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U
Nickel	13.0B	11.1U	11.1U	24.9B	28.9B	25.6B
Potassium	3970B	1360B	6060	5530	3010B	3290B
Selenium	3.0UNW	3.0UN	15.0UENW	15.0UNW	15.0UNW	15.0UENW
Silver	2.4UN	10.0UN	2.4UN	10.0UN	10.0UN	3.3BN
Sodium	16100	16800	38100	35700	49700	48600
Thallium	1.6U	1.6U	1.6U	1.6UW	1.6UW	1.6UW
Vanadium	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN
Zinc	136EN	20.1EN	99.5EN	14.4BEN	13.1BEN	92.5EN

DRAFT

TABLE 7
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SEDIMENT
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	NORMAL RANGE (mg/kg)	RF-SE-01	RF-SE-01D	RF-SE-02	RF-SE-03	RF-SE-04
Aluminum	29000-116000	28800	28300	1930	4530	11800
Antimony	0.22-1.01	98.5N	97.2N	85.4N	99.0N	40.1BN
Arsenic	2.8-10.9	202*	128*	189*	310*	189*
Barium	337-998	260	307	92.1	157	562
Beryllium	0.30-1.56	2.3	2.2B	1.2B	1.1	2.3B
Cadmium	0.01-2.0***	75.6EN	93.1EN	52.8EN	64.9EN	40.3EN
Calcium		39800	50800	56300	51000	96000
Chromium	19-90	57.7N	62.4N	15.8N	14.9N	25.0N
Cobalt	3.6-14.0	13.4B	20.0B	5.8B	19.3	10.4B
Copper	10-43	571	725	183	313	190
Iron	10600-41000	31400	42800	31100	91900	64400
Lead	9-31	6520	6210	3010	5220	2350
Magnesium		14100	14100	13800	11900	10900
Manganese	192-752	3100	5060	2200	2330	42000
Mercury	0.02-0.11	5.9*	8.2*	2.7*	2.4*	1.3*
Nickel	7-32	41.6	51.2	13.2	21.3	97.2
Potassium		4760	4760	886B	1120	2710B
Selenium	0.09-0.56	9.9BNW	14.5NW	11.4NS	43.1N	12.0UNW
Silver	0.01-8***	28.2N	41.3N	10.7N	16.3N	8.0N
Sodium		472B	555B	206B	634	1150B
Thallium	0.1-0.8***	7.1	7.8	13.6S	7.8	6.6B
Vanadium	36-136	65.4	70.6	9.5B	17.8	28.4U
Zinc	31-98	12700	15200	8160	11200	5400

* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

*** - Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

DR

TABLE 8
RICHARDSON FLATS TAILINGS
LIST OF INORGANIC DATA QUALIFIERS
TDD #T08-9204-015

B - Entered if the reported value is less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

E - The reported value is estimated because of the presence of interference. An explanatory note must be included under comments on the Cover Page (if the problem applies to all samples) or on the specific FORM I-IN (if it is an isolated problem).

N - Matrix spiked sample recovery not within control limits.

S - The reported value was determined by the Method of Standard Additions (MSA).

U - Entered if the analyte was analyzed for but not detected, i.e., less than the IDL.

W - Post digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

* - Duplicate analysis is not within control limits.

+ - Correlation coefficient for the MSA is less than 0.995.

APPENDIX A

MEMO TO EPA/OSC DATED AUGUST 6, 1992,
INSPECTION OF THE TAILINGS DAM AT RICHARDSON FLATS

ecology and environment, inc.

1776 SOUTH JACKSON STREET, DENVER, COLORADO 80210, TEL. 303-757-4984

International Specialists in the Environment

Memorandum

To: Mike Zimmerman
EPA-OSC
From: Mike Sullivan
TAT Region 8
Date: 8/6/92
Subject: Inspection of the Tailings Dam at Richardson Flats T08-9204-015.

Under TDD# T08-9204-015 the U. S. Environmental Protection Agency (EPA) tasked the Ecology & Environment, Inc. Technical Assistance Team (TAT) to inspect the Tailings Dam at the Richardson Flats Tailings Pond near Park City, Utah and to provide a report on the findings of the inspection. The inspection did not encompass any trenching or boring in the embankment which would be required for a full assessment of the structure. This report relies heavily on the two reports generated by Dames and Moore, Inc., and on a visual inspection of the structure. The Dames & Moore reports are "Report of Embankment and Die Design Requirements Proposed Tailings Pond Development Near Park City, Utah for Park City Ventures Corporation" (1974) and "Report on Tailing Pond Investigation near Park City, Utah for Noranda Mining, Inc" (1980).

BACKGROUND

The Richardson Flats Tailings Pond, located near Park City, Utah, was a tailings pond which received slurried mill and mine wastes from mining operations in the Park City area. Tailings were transported to the pond via a slurry pipeline. According to the historical records, Richardson Flats was originally a flat area with intermittent drainages and Silver Creek running across it. The area was somewhat marshy and boggy. The original tailings dam was constructed of organic soils excavated from the site and piled up to form a small berm. Later raises for the embankment were constructed, as needed, out of sands, gravels, organic silts, as well as rubbish and garbage (Dames & Moore, Inc 1974).

In 1974 Dames & Moore, Inc. was contracted by Park City Ventures Corporation, the owners of the mine, to investigate enlarging the tailings pond. Dames & Moore Inc., was to provide design requirements for the proposed embankments with special attention given to minimizing seepage of contaminated pond effluent from the tailings pond. The investigation program consisted of exploratory boring, test pits, laboratory analysis for strength characteristics of the soils, and analysis of the data to provide design requirements. The report called for construction of a main embankment, a dike along the southern and northern ends of the pond, and construction of a diversion ditch to route runoff away from the pond.

In 1974 the embankments and diversion ditch were constructed, generally in accordance with the requirements as outlined in the Dames & Moore report.

In 1980 Dames & Moore, Inc. again investigated the structure for Noranda Mining, Inc., the new owners of the mine. As stated in the reports introduction the objective of this investigation was to "... assess the overall condition and usefulness of the existing facilities and to determine what measures will be required for long-term tailings disposal from the Park City mine." In this report Dames & Moore noted that enlargement of the embankment had not been ..."built according to recommendations ..." and that the fill was not "...properly engineered during construction.". Specific problems noted by Dames & Moore in the construction of the main embankment included: oversteepened slopes of approximately 1.5:1.0 in many places, no evidence of internal zoning of the embankment (clay core), the recommended drainage zone at the downstream toe was not installed, and that overall compaction of the material in the embankment was poor. Also noted at this time was "... considerable seepage in the form of small seeps and marshy areas on the northwest abutment and at the downstream toe of the main embankment...". The report recommended adding a drainage blanket to the toe of the embankment, flattening the oversteepened slope of the main embankment, and gave construction sequences for adding to the dikes.

FIELD INSPECTION

On August 4, 1992 TATm Sullivan inspected the main abutment of the Tailings Pond. From visual inspection and referencing the cross sections provided in the Dames & Moore report it appears that the dike was raised from the 1980 levels although not to the ultimate design levels. It is probable that the main embankment was also raised at the same time. No data is available on the construction or construction inspection of this last round of construction. The visual inspection also indicated that the oversteepened slope of the main embankment had not been flattened and that the drainage zone at the toe of the main embankment had not been installed.

The Main Embankment-

The main embankment is about 30 feet high with a slope length of approximately 50 feet. The main embankment is oversteep lying at 1.0:1.0 to 1.5:1.0 (run:rise). Approximately 6" of fine dry sand, possibly windblown tailings, was noted under a 3" topsoil cover layer on the downstream face of the embankment. The sand has no strength and will erode quickly if exposed. A 35% to 50% grass cover was on most of the embankment which will help in erosion control. No cracking was evident on the embankment,although the sand layer would tend to hide any small cracking. Also, no bending (bulging) was noted on the embankment.

Toe of the Main Embankment-

Rank vegetation, in the form of willows and trees, is growing at the toe of the dam. Approximately 8" of loamy damp soils are evident on the toe of the dam. The amount of vegetation and the type of soils on the toe of the dam indicate that the area receives a lot of water. As the wet soils were noted approximately 6 to 8 feet above the stream level this water is probably due to seepage under the dam. Other evidence of seepage from the toe of the dam was evident in the form of; soft marshy areas, rank vegetation including willows, loamy soils, damp soils, and areas where water had been standing (although no standing water was observed on August 4th).

The North Abutment-

A swampy, loamy area on the north abutment, adjacent to where the embankment meets the abutment, was noted. The area was well above the toe of the dam at the location of the north monitoring well. The north abutment well recharged well when bailed. These conditions indicate that water seeps around or through the contact between the abutment and the embankment. Under full head conditions (saturated tailings) this could be an area where failure of the embankment could occur.

Crest of the Main Embankment-

The crest is sloped back toward the tailings pond allowing any water to drain back to the tailings pond. However, small erosional gullies are forming on the crest and downstream face of the dam and could eventually lead to larger gullying on the dam.

Water Flow-

Water elevations behind the embankment are unknown, however the elevation of water in the ditch and the pond south of the tailings pond are probably indicative of the elevation of groundwater behind the embankment. From the information available in the Dames & Moore, Inc. reports, it is unlikely that a cutoff wall was installed around the perimeter of the pond to control seepage under either the embankment or the dike. The piezometer located on the toe of the dam indicated the water level to be 5 feet below ground. The swampy ground and recharge rate of the monitoring well on the north abutment indicates that water flow from some source is occurring. Inspection of the road cut north of the abutment revealed no seeps. Without further investigation it is conservative to use a worst case scenario and assume that the source of the seep is the water in the tailings behind the dam and that the abutment\embankment contact is a drainage path for the water.

Perimeter Dike-

The perimeter dike was probably constructed by stripping materials off of the downstream side and piling the undifferentiated material up as a dike. The slopes are approximately 2.0:1.0. The dike is used as the access road for the pond and its elevation varies from 2 to 5 feet above the level of the tailings in the pond. The dike appears to be in good condition.

Diversion Ditch-

The diversion ditch has been constructed along the perimeter of the tailings pond as designed by Dames & Moore. The ditch depth and width varies, generally getting deeper and wider as it progresses downstream. Standing water was evident in most of the ditch on the southern perimeter of the property. Rushes, sedges, and cattails were growing in the bottom of the ditch along the entire length. Recent work has been performed by the owners in flattening the ditch banks and adding topsoil to the banks. This work is approximately one-half completed. According to the owners, the rest of the ditch is to be similarly regraded and topsoiled. At the time TAT inspected the site, the hillside diversion ditch, on the north perimeter of the tailings pond, had been cut off from the main ditch as a result of topsoil stripping. This important feature should be reconnected to the main ditch as soon as feasible to prevent additional water flowing into the tailings pond.

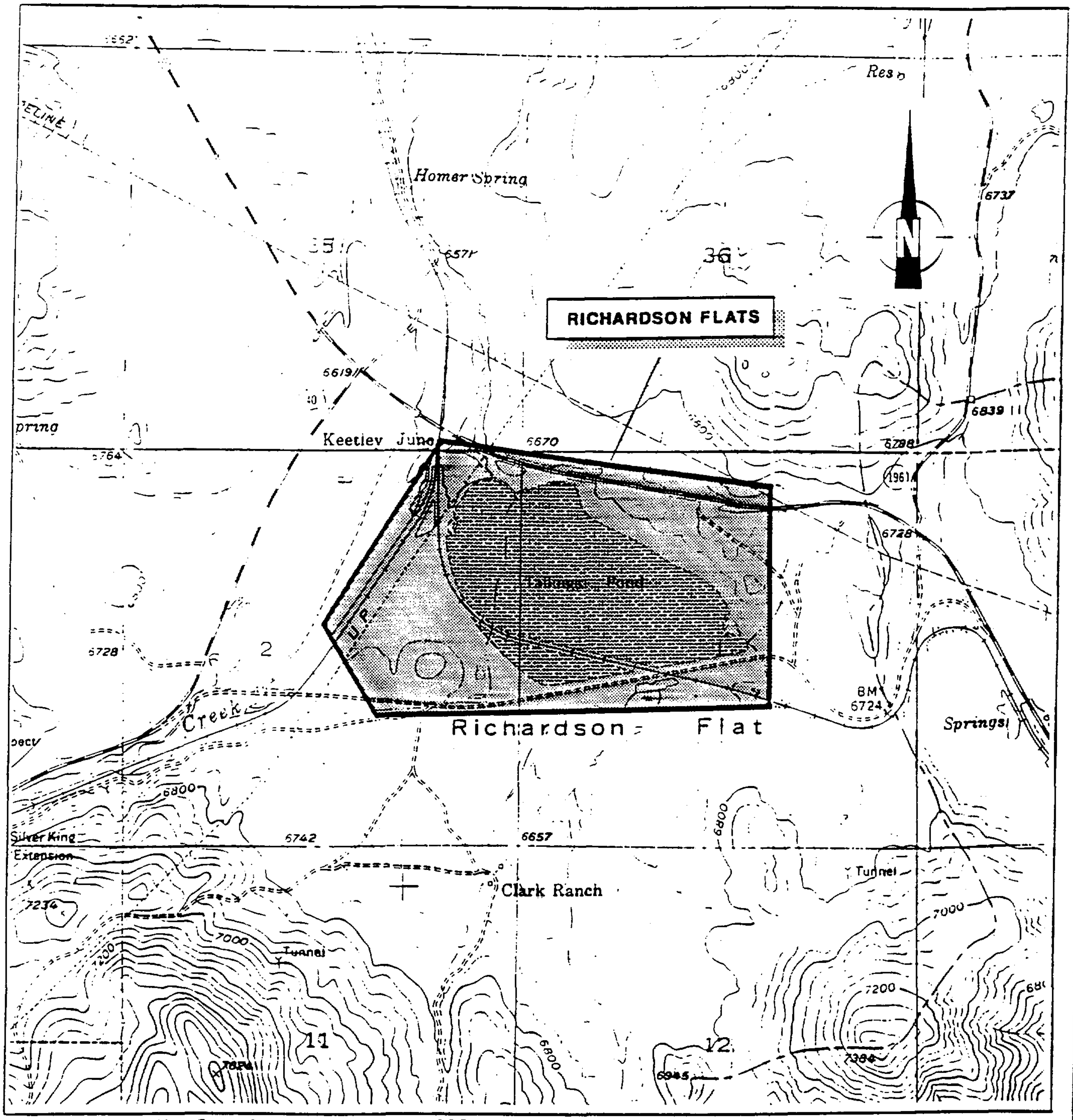
CONCLUSIONS

kBased on TATs inspection, the previous investigation conducted by Dames & Moore, and that the tailings pond seems to be essentially dry, there would appears to be no imminent threat of failure of the main embankment. Failure could occur due to the oversteepened nature of the embankment, especially if the embankment becomes saturated due either to saturation of the tailings or to saturation of the embankment itself. A threat exists of undermining of the dam through the uncontrolled seepage areas located along the toe of the main embankment and on the north abutment. Again the threat would be increased if the tailings become saturated thus increasing the head pressure and possibly the velocity of water flow through the seeps.
The property owners are keeping open the option of reactivating the tailings pond. If the tailings pond is reactivated additional recommended actions are noted in paragraph B. below.

RECOMMENDATIONS

A. Keeping the tailings pond dry through the maintenance of the diversion ditches will do the most to prevent failure of the embankment and a possible release of the tailings into the environment. The connection between the hillside diversion ditch and the perimeter diversion ditch should be restored. In the future, the slopes on the main embankment should be flattened to 2.0:1.0 or greater, and the toe drainage blanket should be installed to allow liquids to drain away from the embankment. A monitoring well should be installed on the top of the tailings pond next to the embankment to monitor the elevation of groundwater within the pond and at the embankment. With water level elevation data available for both upstream of the embankment and at the toe of the embankment better, evaluations of the stability of the structure can be made. If any seeps appear on the embankment they should be monitored for both quantity and quality. Seeps carrying a sediment load generally indicate that active undermining of the embankment may be occurring. Undesirable vegetation in the form of willows and trees should be removed from the embankment.

B. If the pond is to be used for tailings deposition, saturation of the existing tailings is a distinct possibility. With saturation, the possibility of failure of the embankment is raised due to the oversteepened slopes, the existing seeps in the downstream toe of the dam, and the seeps along the north abutment. Saturation of the tailings would increase the head pressure on the seeps, possibly increasing the velocity and amount of water seeping through the embankment. Also, saturation of the tailings will tend to raise the water surface within the embankment itself. Wetting of the material within the embankment can significantly reduce the ability of the material to resist failure. Because the embankment is apparently constructed of undifferentiated materials it would be prudent to add in the drainage blanket at the toe of the embankment and to flatten the embankment as recommended in the 1980 Dames & Moore report. The possibility of a cut-off wall being installed in the embankment should also be investigated. Also, continual monitoring of the seepage from the toe, installation of a network of piezometers and inclinometers is recommended to continually assess the integrity and stability of the embankment.



Source: Park City East Quadrangle, Utah. USGS. 1955

0 1/2 1 MILE

1000 0 1000 2000 3000 4000 5000

LOCATION MAP

LEGEND

Site location

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0037

TITLE:

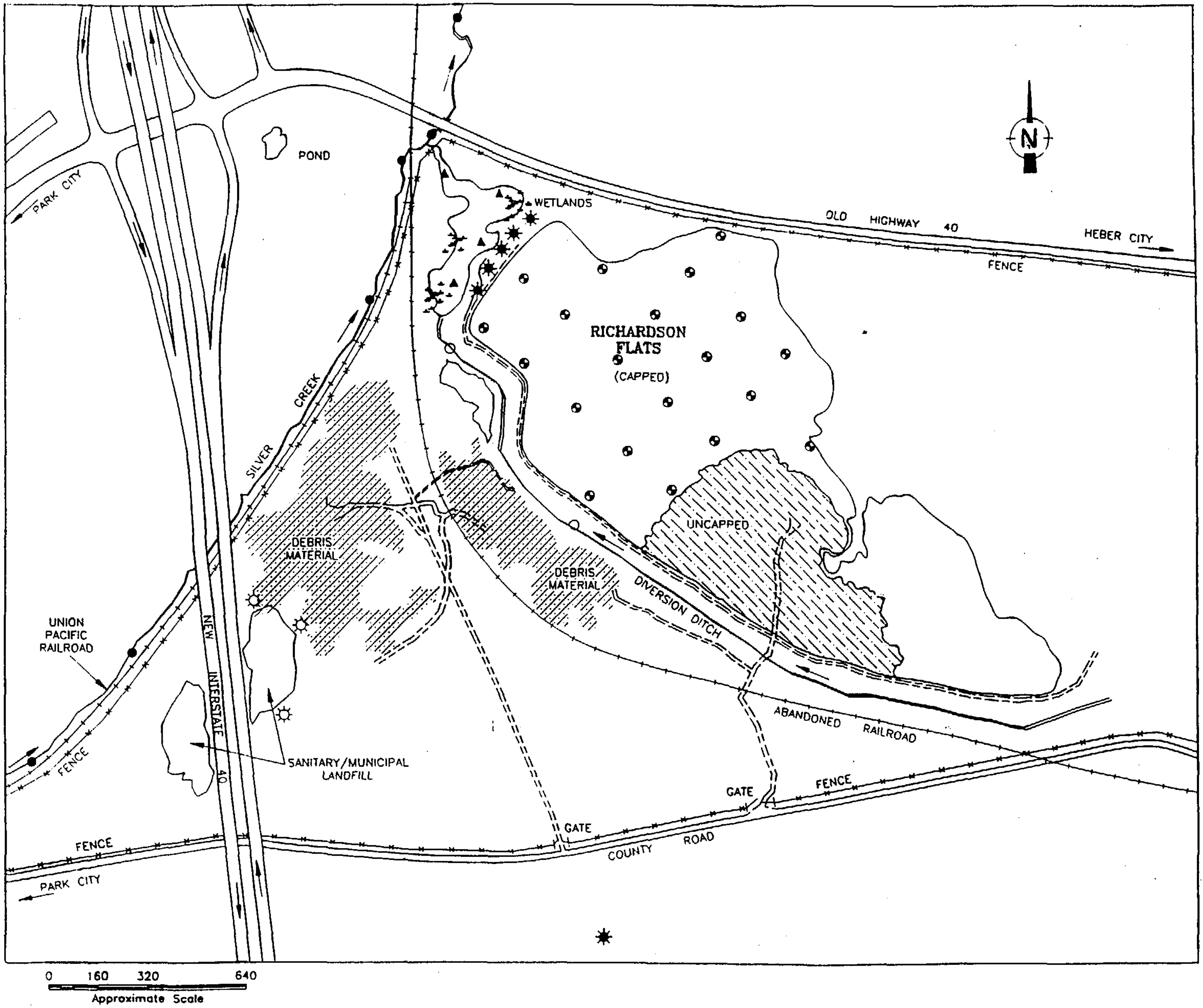
RICHARDSON FLATS
Park City, Utah
SITE LOCATION MAP

T.D.D. T08-9204-015

ecology & environment, inc.
DENVER, COLORADO

FIG. 1

Date: 05/92 Drawn by: RSM Scale:



LEGEND

- ✱ Approximate location of existing monitoring wells to be sampled
- ☼ Proposed monitoring wells to be installed and sampled
- ● Location of surface water samples from Silver Creek
- ○ Surface water samples from diversion ditch (Two upgradient locations will be determined at the time of sampling in the Northeast portion of the site)
- ▲ Location of sediment samples
- ⊕ Location of soil boring

Note: All air samples will be collected off site

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION *EPA CONTRACT 68-WO-0037*	
TITLE: RICHARDSON FLATS Park City, Utah SAMPLE LOCATION MAP T.D.D. T08-9204-015	
ecology & environment, inc. DENVER, COLORADO	FIG. 2
Date: 05/92 Drawn by: RSM Scale:	

TABLE 1
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER
CONCENTRATION IN µg/l
TDD #T08-9204-015

	RF-GW-04		RF-GW-05		RF-GW-09	
ANALYTE	TOTAL	DISSOLVED (FILTERED)	TOTAL	DISSOLVED (FILTERED)	TOTAL	DISSOLVED (FILTERED)
Aluminum	15700	191B	2690	49.6B	68.5B	1630
Antimony	24.3U	33.2B	24.3U	40.5B	35.9B	28.4B
Arsenic	3.7B	3.6U	5.2B	3.6UW	8.8B	11.3
Barium	196B	93.9B	99.6B	64.8B	46.2B	58.3B
Beryllium	1.3B	0.90U	3.4B	1.8B	3.7B	4.9B
Cadmium	3.3U	3.3U	3.3U	3.3U	3.3U	3.3U
Calcium	42200	43500	191000	196000	365000	318000
Chromium	10.5	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	11.0B	6.0U	7.5B	6.0U	6.0U	9.0B
Copper	30.0	171EN*	30.0	20.0B	20.0U	20.0U
Iron	14100	151	3180	62.6B	2170	3190
Lead	627N*	40.9N*	15.6NS*	2.2UN*	2.2U	31.0NS*
Magnesium	12200	8380	44200	41800	55000	52500
Manganese	162E	19.5E	890E	684E	7420E	6670E
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U
Nickel	13.0B	11.1U	11.1U	24.9B	28.9B	25.6B
Potassium	3970B	1360B	6060	5530	3010B	3290B
Selenium	3.0UNW	3.0UN	15.0UENW	15.0UNW	15.0UNW	15.0UENW
Silver	2.4UN	10.0UN	2.4UN	10.0UN	10.0UN	3.3BN
Sodium	16100	16800	38100	35700	49700	48600
Thallium	1.6U	1.6U	1.6U	1.6UW	1.6UW	1.6UW
Vanadium	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN
Zinc	136EN	20.1EN	99.5EN	14.4BEN	13.1BEN	92.5EN

TABLE 2
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SURFACE WATER
CONCENTRATION IN μg/l
TDD #T08-9204-015

ANALYTE	RF-SW-01	RF-SW-02	RF-SW-03	RF-SW-04	RF-SW-05	RF-SW-06	RF-SW-07	RF-SW-08
Aluminum	20.3B	70.1B	19.3B	65.5B	17.1U	185B	36.7B	319
Antimony	36.7B	24.8B	24.3U	38.7B	24.3U	30.1B	24.3U	24.3U
Arsenic	4.2B	5.2B	7.3B	7.6B	7.2B	12.5	5.7B	11.4
Barium	49.2B	54.6B	50.5B	54.4B	65.6B	66.0B	32.7B	54.3B
Beryllium	3.4B	2.8B	2.1B	2.1B	2.4B	0.93B	3.2B	1.0B
Cadmium	3.9B	3.3U	3.3U	3.5B	3.3U	3.3U	3.3U	3.3U
Calcium	233000	157000	128000	149000	163000	146000	341000	190000
Chromium	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	6.0U	6.0U	6.0U	10.4B	6.0U	6.0U	6.0U	6.0U
Copper	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0B
Iron	193	158	307	356	279	446	703	1320
Lead	35.3NS*	18.8N*	15.0N*	36.4NS*	151NS*	33.2N*	33.3NS*	146NS*
Magnesium	38700	37000	30600	33600	36700	37700	61000	38100
Manganese	249E	495E	458E	438E	269E	399E	9230E	1590E
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U	0.24	0.20U
Nickel	11.1U	25.4B	11.1U	11.1U	11.1U	11.1U	12.8B	20.9B
Potassium	3510B	2110B	1640B	1950B	1270B	1400B	3180B	1150B
Selenium	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW	15.0UENW
Silver	2.4UN	2.4UN	2.4UN	2.4UN	2.4UN	10.0N	10.0N	10.0UN
Sodium	63600	24500	20900	25500	25900	27600	51200	29500
Thallium	1.6UW	1.6U	1.6U	1.6U	1.6U	1.6U	1.6UW	1.6U
Vanadium	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN	35.7UN
Zinc	1110EN	2080EN	769EN	776EN	466EN	321EN	64.2EN	745EN

TABLE 3
NUMERIC STANDARDS OF QUALITY
SILVER CREEK
STATE OF UTAH
WASTEWATER DISPOSAL REGULATIONS

	DOMESTIC SOURCE (1C) (Max. μg/l)	AQUATIC WILDLIFE (3A) 4 Day Avg./1 Hr. Avg. (μg/l)	AGRICULTURAL (Max. μg/l)	HUMAN HEALTH (μg/l)
Antimony				146
Arsenic	50	190/360 (tri As)	100	.002
Barium	1000			
Beryllium				.0037
Cadmium	10	2.5/12.5[A]	10	10
Chromium	50	11/16 (hex Cr) 480/4035 (tri Cr)[A]	100	50
Copper		28.5/47[A]	200	1000
Iron		1000 (Max.)		
Lead	50	2.5/5.7[A]	100	50
Mercury	2	.012/2.4		.144
Nickel		377/3390[A]		13.4
Selenium	10	5/20	50	10
Silver	50	/24[A]		50
Zinc		254/280[A]		5000

[A] - Based on hardness level of 280 mg/l as $CaCO_3$.

TABLE 4
FEDERAL QUALITY CRITERIA FOR WATER
RICHARDSON FLATS TAILINGS
TDD #T08-9204-015
(Concentration in µg/l Unless Otherwise Stated)

	CRITERIA FOR PROTECTION OF FRESH WATER WILDLIFE		CRITERIA FOR PROTECTION OF HUMAN HEALTH	
	ACUTE CRITERIA	CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY
Antimony	9000*	1600*	1.46	
Arsenic	850 (pent)* 360 (tri)	48 (pent)* 190 (tri)	2.2 ng/l**	17.5 ng/l**
Barium			1 mg/l	
Beryllium	130*	5.3*	6.8 ng/l**	117 ng/l**
Cadmium	12.5A	2.5A	10	
Chromium (hex)	16	11	50	
Chromium (tri)			170 mg/l	3433 mg/l
Copper	46.8A	28.5A		
Iron		1000	0.3 mg/l	
Lead	303A	11.8A	50	
Manganese			50	100
Mercury	2.4	0.012	144 ng/l	146 ng/l
Nickel	3390A	377A	13.4	100
Selenium	260	35	10	
Silver	24A	.12	50	
Thallium	1400*	40*	13	48
Zinc	280A	254A		

From: Quality Criteria for Water, 1986, EPA 440/5-86-001.

A - Calculated based on hardness at 280 mg/l $CaCO_3$.

* - Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).

** - Human health criteria for carcinogens reported for three risk levels. Values presented is the 10^{-6} risk level.

TABLE 5
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SOIL
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	RF-SO-01	RF-SO-02	RF-SO-03	RF-SO-04	RF-SO-05	RF-SO-06
Aluminum	21200	25300	2960	25800	22000	25200
Antimony	5.0UN	5.0UN	142N	5.0UN	5.7BN	5.6BN
Arsenic	20.9S*	3.5*	357*+	5.9*	16.6	8.9
Barium	253	282	117	267	317	197
Beryllium	1.1	1.1	1.2	1.2	1.1	1.2
Cadmium	3.0EN	1.8EN	83.0EN	1.9EN	5.0EN	2.4EN
Calcium	5850	5900	59200	5900	9480	4920
Chromium	24.4N	27.9N	12.9N	22.2N	24.3N	28.2N
Cobalt	13.9	12.7	12.6	15.0	14.5	10.0B
Copper	31.4	24.8	454	27.2	50.4	29.4
Iron	21800	25600	67300	23500	27500	23100
Lead	111	34.9S	5770	125+	223	102
Magnesium	4910	5200	10100	5150	4780	5570
Manganese	1190	637	2020	899	1030	697
Mercury	0.11U*	0.11U*	3.6*	0.10U*	0.11U*	0.16*
Nickel	20.7	21.6	18.5	18.4	21.3	19.9
Potassium	4730	4580	917	4330	4540	5650
Selenium	0.61UNW	0.61UNW	25.4N	0.61UNW	0.61UNW	0.61UNW
Silver	4.1N	2.0N	20.3N	2.0N	2.0N	2.0N
Sodium	136B	319B	209	244B	248B	159B
Thallium	0.35B	0.43B	41.7S	0.59B	1.9B	0.32U
Vanadium	41.4	56.3	13.0	51.4	57.4	42.2
Zinc	214	96.3	10000	127	432	184

TABLE 6

Normal Ranges of Elemental Concentrations in Soils
of the Western United States*.
All Measurements are in (mg/kg) ppm.

ELEMENT	MEAN**	NORMAL RANGE MEAN+1 s.d.**
Aluminum	58,000	29,000-116,000
Antimony	0.47	0.22-1.01
Arsenic	5.5	2.8-10.9
Barium	580	337-998
Beryllium	0.68	0.30-1.56
Cadmium	0.35***	0.01-2.0***
Chromium	41	19-90
Cobalt	7.1	3.6-14.0
Copper	21	10-43
Iron	21,000	10,600-41,000
Lead	17	9-31
Manganese	380	192-752
Mercury	0.05	0.02-0.11
Nickel	15	7-32
Selenium	0.23	0.09-0.56
Silver	0.5***	0.01-8***
Thallium	0.2***	0.1-0.8***
Tin	0.9	0.4-1.9
Vanadium	70	36-136
Zinc	55	31-98
Molybdenum	0.85	0.39-1.85
Thorium	9.1	6.1-13.6
Uranium	2.5	1.7-3.6
Yttrium	22	13-37

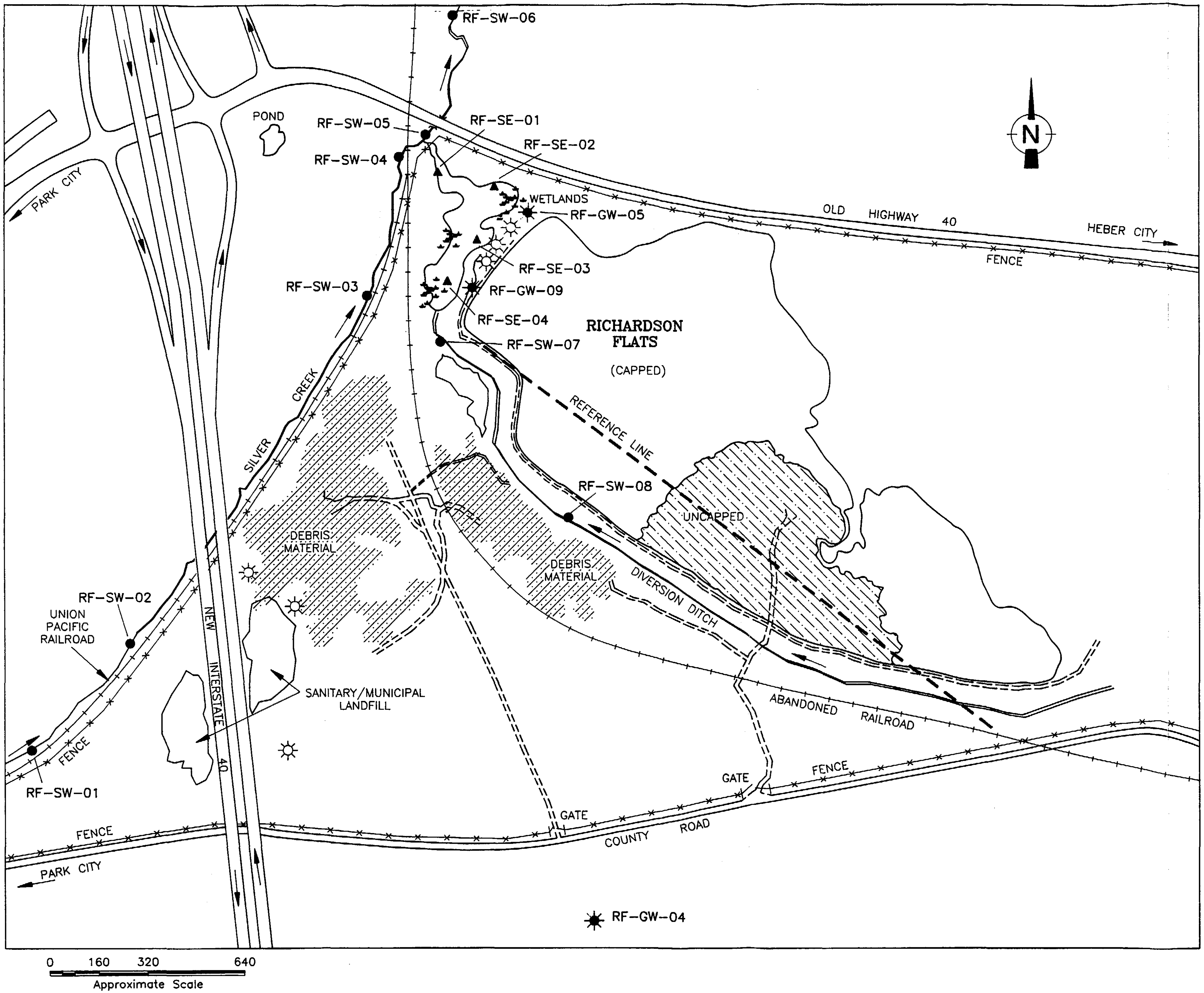
* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

** Means and Standard Deviations are <u>Geometric</u> to account for lognormal distrubutions.

*** Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

TABLE 7
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SEDIMENT
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	RF-SE-01	RF-SE-01D	RF-SE-02	RF-SE-03	RF-SE-04
Aluminum	28800	28300	1930	4530	11800
Antimony	98.5N	97.2N	85.4N	99.0N	40.1BN
Arsenic	202*	128*	189*	310*	189*
Barium	260	307	92.1	157	562
Beryllium	2.3	2.2B	1.2B	1.1	2.3B
Cadmium	75.6EN	93.1EN	52.8EN	64.9EN	40.3EN
Calcium	39800	50800	56300	51000	96000
Chromium	57.7N	62.4N	15.8N	14.9N	25.0N
Cobalt	13.4B	20.0B	5.8B	19.3	10.4B
Copper	571	725	183	313	190
Iron	31400	42800	31100	91900	64400
Lead	6520	6210	3010	5220	2350
Magnesium	14100	14100	13800	11900	10900
Manganese	3100	5060	2200	2330	42000
Mercury	5.9*	8.2*	2.7*	2.4*	1.3*
Nickel	41.6	51.2	13.2	21.3	97.2
Potassium	4760	4760	886B	1120	2710B
Selenium	9.9BNW	14.5NW	11.4NS	43.1N	12.0UNW
Silver	28.2N	41.3N	10.7N	16.3N	8.0N
Sodium	472B	555B	206B	634	1150B
Thallium	7.1	7.8	13.6S	7.8	6.6B
Vanadium	65.4	70.6	9.5B	17.8	28.4U
Zinc	12700	15200	8160	11200	5400



LEGEND

- Approximate location of monitoring wells
- Groundwater sample location
- Surface water sample location
- Sediment sample location

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION EPA CONTRACT 68-WO-0037	
TITLE: RICHARDSON FLATS Park City, Utah SAMPLE LOCATION MAP T.D.D. T08-9204-015	
ecology & environment, inc. DENVER, COLORADO	FIG. 1
Date: 08/92 Drawn by: RSM Scale:	